

REMARKS

Claims 1, 4-10, 12-14, and 21-28 are currently pending in the application. By this amendment, claims 1, 4-6, 8, 12, and 21 are amended and claims 27 and 28 are added for the Examiner's consideration. Claims 2, 3, and 11 are canceled without prejudice or disclaimer. The above amendments do not add new matter to the application and are fully supported by the original disclosure. For example, support for the amendments is provided in the claims as originally filed, at Figures 1-6, 11, and 12, and at paragraphs 0017-0028 and 0034-0036 of Applicants' published application (i.e., U.S. Pub No. 2006/0073394). Reconsideration of the rejected claims in view of the above amendments and the following remarks is respectfully requested.

Amendments to the Claims

Applicants have amended claims 1, 4-6, 8, 12, and 21 and cancelled claims 2, 3, and 11 from further consideration in this application. Applicants are not conceding in this application that those claims are not patentable over the art cited by the Examiner, as the present claim amendments and cancellations are only for facilitating expeditious prosecution of the allowable subject matter noted by the examiner. Applicants respectfully reserve the right to pursue these and other claims in one or more continuations and/or divisional patent applications.

35 U.S.C. §103 Rejection

Claims 1-8, 11-14, and 21-23 are rejected under 35 U.S.C. §103(a) for being unpatentable over U.S. Pat. No. 4,538,748 issued to Gruner et al. ("Gruner") in view of what the Examiner characterizes as "Applicants' Admitted Prior Art." Applicants note that claims 24-26 are not

listed as rejected at page 2 of the Office Action, yet pages 4-5 of the Office Action set forth an explanation of a rejection of claims 23-26. Clarification of this inconsistency is requested.

Claims 9 and 10 are rejected under 35 U.S.C. §103(a) for being unpatentable over Gruner and “Applicants’ Admitted Prior Art,” and further in view of U.S. Pub. No. 2005/0106837 issued to Nakai et al. (“Nakai”). These rejections are respectfully traversed.

To establish a *prima face* case of obviousness, all claim limitations must be taught or suggested by the prior art. *See, In re Royka*, 490 F.2d 981, 985, 180 USPQ 580, 583 (CCPA 1974); *see also, In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). Applicants submit that the applied art fails to disclose or suggest all of the features of the claimed invention.

Claims 1-8, 11-14, and 21-23

Independent claim 1

The invention relates to semiconductor fabrication, and more particularly to fabricating a combination of small and large structures. In embodiments, a target shape for fabrication has a narrow section and a wide section. According to aspects of the invention, a sidewall image transfer (SIT) loop is formed as a hard mask over portions of the target shape, the SIT loop having a width that is equal to and coincident with a width of the narrow section of the target shape. A follow-on mask may be formed over portions of the SIT loop and the target shape. For example, the follow-on mask may have a first (narrow) portion formed over the narrow section of the target shape, wherein the first (narrow) portion of the follow-on mask has a width that exceeds the width of the narrow section of the target shape. Also, the follow-on mask may have a second (wide) portion formed over the wide section of the target shape, wherein the second (wide) portion of the follow-on mask has a width that exceeds the width of the wide section of the target shape.

The follow-on mask enables cutting the SIT loop into segments and adds larger features to the image formed by the SIT loop, without interfering with the accuracy for those portions of the final image formed by the SIT loop. In this manner, implementations of the invention provide a reduction in the number of masks required to form a final image, especially when combining SIT imaging processes with traditional masking techniques. More specifically, independent claim 1 has been amended to recite:

1. A method of semiconductor fabrication, comprising the steps of:
 - forming a sidewall image transfer (SIT) loop on a substrate such that the SIT loop forms a hard mask having a width substantially equal to a critical width of a narrow section of a target shape;
 - protecting a pair of critical edges of the hard mask on the substrate with a first portion of a follow-on mask, wherein a width of the first portion of the follow-on mask exceeds the critical width by an amount of overlap, and a width of a wide section of the follow-on mask exceeds a width of a wide section of the target shape;
 - removing an exposed portion of the hard mask that is not covered by the follow-on mask; and
 - exposing the pair of critical edges of the hard mask by etching the follow-on mask to reduce the width of the first portion of the follow-on mask to less than the critical width.

The Examiner asserts that it would have been obvious to modify the teachings of Gruner based on the description of sidewall image transfer techniques set forth in the Background section of Applicants' specification. Notwithstanding, Applicants submit that no proper combination of the applied art discloses or suggests the combination of features recited in claim 1, as amended herein.

As the Examiner acknowledges, Gruner does not disclose sidewall image transfer (SIT) techniques. Instead, Gruner only discloses photo-lithographic imaging. Although Applicants generally describe SIT techniques in the Background section of the specification, Applicants do not acquiesce in the Examiner's assertion that the features of the claims are "admitted prior art."

In any event, Applicants submit that no proper combination of Gruner and “Applicants’ Admitted Prior Art” teaches: (i) *a width of the first portion of the follow-on mask exceeds the critical width by an amount of overlap, and a width of a wide section of the follow-on mask exceeds a width of a wide section of the target shape*; and (ii) *exposing the pair of critical edges of the hard mask by etching the follow-on mask to reduce the width of the first portion of the follow-on mask to less than the critical width*.

More specifically, the applied art fails to disclose or suggest *protecting a pair of critical edges of the hard mask on the substrate with a first portion of a follow-on mask, wherein a width of the first portion of the follow-on mask exceeds the critical width by an amount of overlap, and a width of a wide section of the follow-on mask exceeds a width of a wide section of the target shape*. The Examiner asserts that Gruner’s photoresist mask 90 is a follow-on mask that protects critical edges of the hard mask 5 (Office Action, pages 2-3). Notwithstanding, Applicants submit that mask 90 does not have both (1) a first portion whose width exceeds the critical width by an amount of overlap, and (2) a wide section whose width exceeds a width of a wide section of the target shape. To the contrary, Gruner’s mask 90 does not extend width-wise beyond the width of any shape that it covers (see, e.g., FIGS. 2e-2h).

Moreover, Gruner does not disclose a target shape having a narrow section and a wide section. Instead, Gruner only shows side views of the semiconductor structure, and makes no mention of a target shape that has both a narrow section and a wide section. Therefore, Gruner cannot reasonably be construed as teaching *protecting a pair of critical edges of the hard mask on the substrate with a first portion of a follow-on mask, wherein a width of the first portion of the follow-on mask exceeds the critical width by an amount of overlap, and a width of a wide*

section of the follow-on mask exceeds a width of a wide section of the target shape, as recited in claim 1.

In further contrast to the claimed invention, Gruner does not disclose or suggest *exposing the pair of critical edges of the hard mask by etching the follow-on mask to reduce the width of the first portion of the follow-on mask to less than the critical width*. Gruner does not disclose critical edges of a hard mask, does not disclose a critical width, and does not disclose etching the follow-on mask to reduce the width of the first portion of the follow-on mask to less than the critical width. Instead, Gruner only discloses conventional photolithographic techniques utilizing photoresist mask 90. Put another way, Gruner does not disclose or suggest reducing a width of a portion of the mask 90 to less than a critical width to expose critical edges of a hard mask, where the width of the portion of the mask 90 initially exceeded the critical width by an amount of overlap.

The description in the Background section of Applicants' specification does not cure the above-noted deficiencies of Gruner with respect to independent claim 1. Particularly, Applicants do not disclose or suggest *protecting a pair of critical edges of the hard mask on the substrate with a first portion of a follow-on mask, wherein a width of the first portion of the follow-on mask exceeds the critical width by an amount of overlap, and a width of a wide section of the follow-on mask exceeds a width of a wide section of the target shape and exposing the pair of critical edges of the hard mask by etching the follow-on mask to reduce the width of the first portion of the follow-on mask to less than the critical width* in the Background section of the specification. Nor have Applicants admitted that such features are prior art. Instead, Applicants only generally describe sidewall image transfer (SIT) techniques in the Background section of

the specification. Therefore, no proper combination of Gruner and “Applicants’ Admitted Prior Art” teaches the combination of features recited in claim 1.

Independent claim 8

Independent claim 8 has been amended to recite:

8. A method of semiconductor fabrication, comprising the steps of:
forming a sidewall image transfer (SIT) loop on a substrate such that the SIT loop forms a hard mask, wherein a width of the hard mask substantially equals a width of a narrow section of a target shape;
forming a follow-on mask in a loop-cutter pattern on a portion of the hard mask, wherein the follow-on mask comprises a wide-image section having a width that exceeds a width of a wide section of the target shape and a narrow-image section having a width that exceeds the width of the hard mask;
removing a portion of the hard mask left exposed by the follow-on mask;
and
removing at least a portion of the narrow-image section of the follow-on mask.

Applicants submit that no proper combination of the applied art discloses or suggests the combination of features recited in claim 8. For example, Gruner cannot reasonably be said to disclose *forming a sidewall image transfer (SIT) loop on a substrate such that the SIT loop forms a hard mask, wherein a width of the hard mask substantially equals a width of a narrow section of a target shape*, as recited in claim 8. More specifically, Gruner does not disclose a sidewall image transfer (SIT) loop, and does not disclose teach a target shape having both a wide section and a narrow section. Instead, Gruner discloses conventional photolithography (without mentioning SIT techniques), and shows side views of a structure in which no shape has both a wide section and a narrow section. Therefore, Gruner cannot reasonably be said to disclose *forming a sidewall image transfer (SIT) loop on a substrate such that the SIT loop forms a hard mask, wherein a width of the hard mask substantially equals a width of a narrow section of a target shape*.

Moreover, Gruner does not even disclose a loop. Instead, Gruner only discloses side views of the structure. Therefore, Gruner cannot be construed as disclosing *forming a follow-on mask in a loop-cutter pattern on a portion of the hard mask*, as recited in claim 8.

Additionally, as discussed above with respect to claim 1, Gruner does not disclose a follow on mask that has a wide-image section having a width that exceeds a width of a wide section of the target shape and a narrow-image section having a width that exceeds the width of the hard mask. To the contrary, Gruner's photoresist mask 90 does not extend width-wise beyond the width of any shape that it covers. Therefore, Gruner does not teach *the follow-on mask comprises a wide-image section having a width that exceeds a width of a wide section of the target shape and a narrow-image section having a width that exceeds the width of the hard mask*, as recited in claim 8.

As also discussed above with respect to claim 1, Applicants submit that the description in the Background section of Applicants' specification does not cure the above-noted deficiencies of Gruner with respect to independent claim 8. Instead, Applicants only generally describe sidewall image transfer (SIT) techniques in the Background section of the specification. Therefore, no proper combination of Gruner and "Applicants' Admitted Prior Art" teaches the combination of features recited in claim 8.

Independent claim 21

Independent claim 21 has been amended to recite:

21. A method of combining a wide-image mask and loop-cutter mask, comprising the steps of:

forming a sidewall image transfer (SIT) hard mask loop on a substrate, wherein a width of a narrow section of a target shape substantially equals a width of the hard mask loop, and a width of a wide section of the target shape exceeds the width of the hard mask loop;

forming a follow-on mask over a portion of the hard mask loop, wherein the follow-on mask includes a first section corresponding to the wide section of

the target shape and a second section overlapping the narrow section of the target shape, and a width of the second section of the follow-on mask exceeds the width of the narrow section of the target shape;

removing regions of the hard mask loop uncovered by the follow on mask;
etching the second section of the follow-on mask to expose underlying edges of the hard mask loop;

etching the first section of the follow-on mask to reduce its length and width to produce an image pad that substantially conforms to the wide section of the target shape; and

etching the substrate uncovered by the remaining hard mask loop and image pad

Applicants submit that no proper combination of the applied art discloses or suggests the combination of features recited in claim 21. For example, Gruner does not disclose *forming a sidewall image transfer (SIT) hard mask loop on a substrate, wherein a width of a narrow section of a target shape substantially equals a width of the hard mask loop, and a width of a wide section of the target shape exceeds the width of the hard mask loop*. Instead, Gruner discloses conventional photolithography, and does not disclose SIT techniques. Moreover, Gruner only discloses side views of a semiconductor structure, none of which depict a loop. Additionally, Gruner only shows side views of a structure in which no target shape has both a wide section and a narrow section. Therefore, Gruner cannot be construed as disclosing *forming a sidewall image transfer (SIT) hard mask loop on a substrate, wherein a width of a narrow section of a target shape substantially equals a width of the hard mask loop, and a width of a wide section of the target shape exceeds the width of the hard mask loop*, as recited in claim 21.

Additionally, Gruner does not disclose *forming a follow-on mask over a portion of the hard mask loop, wherein the follow-on mask includes a first section corresponding to the wide section of the target shape and a second section overlapping the narrow section of the target shape, and a width of the second section of the follow-on mask exceeds the width of the narrow section of the target shape*, as recited in claim 21. Gruner simply does not disclose a follow on

mask that includes both: (1) a first section that corresponds to a wide section of a target shape and (2) a second section that overlaps a narrow section of the target shape and has a width exceeding the narrow section of the target shape. To the contrary, Gruner's photoresist mask 90 does not extend width-wise beyond the width of any shape that it covers.

Furthermore, Gruner does not disclose or suggest *etching the first section of the follow-on mask to reduce its length and width to produce an image pad that substantially conforms to the wide section of the target shape*, as recited in claim 21. Gruner does not disclose etching a section of photoresist mask 90 to reduce its length and width. Instead, Gruner only discloses side views of the fabrication, and makes no mention of reducing a length and width of a feature as seen from above, as in Applicants' claimed invention.

Additionally, Gruner does not disclose an image pad as recited in the claimed invention. To the contrary, Gruner is completely silent as to an image pad that substantially conforms to the wide section of the target shape. Moreover, Applicants note that the Examiner failed to address the recitation regarding an image pad in the Office Action.

As discussed above with respect to claims 1 and 8, Applicants submit that the description in the Background section of Applicants' specification does not cure the above-noted deficiencies of Gruner with respect to independent claim 8. Instead, Applicants only generally describe sidewall image transfer (SIT) techniques in the Background section of the specification. Therefore, no proper combination of Gruner and "Applicants' Admitted Prior Art" teaches the combination of features recited in claim 1.

Dependent Claims 4-7, 12-14, 22, and 23

Claims 4-7, 12-14, 22, and 23 depend from independent claims 1, 8, and 21, respectively, and are distinguishable from the applied art at least for the reasons discussed above with respect

to the independent claims. Moreover, the applied art fails to disclose or suggest many of the additional features recited in these dependent claims. For example, the applied art does not disclose or suggest *the exposing the pair of critical edges of the hard mask comprises etching the first portion of the follow-on mask from a side of the first portion of the follow-on mask*, as recited in claim 4. Claims 2, 3, and 11 are canceled without prejudice or disclaimer, thereby rendering the rejection of these claims moot.

Accordingly, Applicants respectfully request that the §103 rejection of claims 1-8, 11-14, and 21-23 be withdrawn.

Claims 9 and 10

Claims 9 and 10 are rejected under 35 U.S.C. §103(a) for being unpatentable over Gruner in view of “Applicants’ Admitted Prior Art,” and further in view of Nakai. This rejection is respectfully traversed. Claims 9 and 10 depend from independent claim 8 and are distinguishable from the applied art at least for the reasons discussed above with respect to independent claim 8. Moreover, the applied fails to disclose or suggest many of the additional features recited in dependent claims 9 and 10. For example, the applied art does not disclose or suggest *sizing the wide-image section of the follow-on mask to substantially align with a corresponding wide section of a final structure*, as recited in claim 10.

Accordingly, Applicants respectfully request that the §103 rejection of claims 9 and 10 be withdrawn.

New Claims

New claims 27 and 28 are added by this amendment and depend from independent claims 1 and 8, respectively. As such, new claims 27 and 28 are allowable at least for the reasons

discussed above with respect to independent claims 1 and 8. Moreover, the applied art does not disclose or suggest many of the additional features recited in these claims.

CONCLUSION

In view of the foregoing amendments and remarks, Applicants submit that all of the claims are patentably distinct from the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue. The Examiner is invited to contact the undersigned at the telephone number listed below, if needed. Applicants hereby make a written conditional petition for extension of time, if required. Please charge any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 09-0456.

Respectfully submitted,
Toshiharu FURUKAWA et al



Andrew M. Calderon
Registration No. 38,093

January 5, 2009
Greenblum & Bernstein, P.L.C.
1950 Roland Clarke Place
Reston, Virginia 20191
Telephone: 703-716-1191